IRRIGATED LAND ASSESSMENT OF THE UPPER CLARK FORK DRAINAGE

June, 1984

Interim Report

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June 27, 1984

Mr. Larry Peterman
Water Resources Supervisor
Montana Department of Fish,
Wildlife and Parks
1420 East Sixth Avenue
Helena, Montana 59620

Dear Larry:

The attached report summarizes the work that I have done to date on Tasks 1 and 2 of the Upper Clark Fork Study. Please note that I have not discussed the proposed work of the U.S. Geological Survey (USGS) on heavy metal/sediment interactions within the Clark Fork River. According to Brace Hayden, the USGS has allocated funds to study hydrological aspects of heavy metal chemistry within the Clark Fork River.

Before we proceed with the next tasks on this project, I believe that it is essential to meet with the Department of Natural Resources and Conservation and other appropriate agencies or parties to devise the most efficient and practical means to meet the objectives of the study. Please let me know when this meeting has been scheduled. Thank you.

Sincerely,

Joe C Elliott

Joe C. Elliott

Attachment
JCE:ldp

cc: Brace Hayden, Governor's Office

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Submitted to:

Montana Department of Fish, Wildlife and Parks
1420 East Sixth Avenue
Helena, Montana 59620

Submitted by:

Joe C. Elliott
Ecological Consultant
835 Eighth Avenue
Helena, Montana 59601

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I. INTRODUCTION

The Montana Department of Fish, Wildlife and Parks (DFWP) is preparing a water reservation request for the Upper Clark Fork drainage to be submitted to the Montana Department of Natural Resources and Conservation (DNRC) for review and analysis. One aspect of the water reservation request concerns the status of irrigated land and potentially irrigable land within the Upper Clark Fork Valley. Because agriculture uses 82 percent of the water consumed in Montana (versus 17 percent for reservoir evaporation, 1 percent for municipal and domestic use, and 1 percent by industry), agricultural demands for water must be assessed when allocating future water use.

This report briefly discusses the status of efforts to map irrigated and potentially irrigable lands within the Upper Clark Fork drainage and the constraints to irrigation such as heavy metal contamination of soil. Proposed methods to provide a current assessment of irrigated lands and potentially irrigable lands are also presented.

II. UPPER CLARK FORK DRAINAGE

The Upper Clark Fork drainage has approximately 66,000 acres of irrigated land (Guehlstorff 1984) with the largest blocks occurring between Warm Springs and Drummond and in the Flint Creek Valley. Additionally, an unknown number of acres of arable land not now being irrigated could be brought under irrigation if additional water were to become available and if the cost of supplying that water were economically acceptable to potential users.

In order for additional water to become available, some type of storage facility would have to be constructed. According to Oellerman (1984), the most cost-effective storage facility would be an off-stream facility which would not have to be designed to withstand major floods. Main stem reservoirs often become prohibitive from a cost standpoint because of the high expense of constructing a suitable spillway to handle major floods.

Additional water could become available; however, in the Upper Clark Fork drainage it may not be economically feasible to bring new lands under irrigation. According to the Pacific Northwest River Basins Commission (1971), there are currently about 18,000 acres of irrigated lands in the Upper Clark Fork drainage[1] which do not have adequate water to

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[1]The Upper Clark Fork described by the Pacific Northwest River Basins Commission includes the Blackfoot River drainage, whereas the Upper Clark Fork region described by Guehlstorff (1984) does not include the Blackfoot River.

maintain full service, season long irrigation. Any additional water that may become available might better be used to supply established irrigated agriculture rather than to develop new areas. Before, however, such a determination can be made, a detailed analysis is required to locate where irrigation demands are not currently being met and where potential expansion of irrigated land is feasible from an agronomic and economic standpoint.

The Granite County Conservation District is currently studying dam sites for possible water developments in the Flint Creek Valley. One site is on Boulder Creek near Princeton and another is at the existing Willow Creek reservoir. Both sites would provide gravity feed irrigation water to extensive areas which are not now irrigated. The Boulder Creek dam would allow 5,000 to 7,000 acres to be converted from range to irrigated cropland. The acreage that could be irrigated from the Willow Creek dam would depend upon the height of a new dam.

Based on the DNRC designation (Montana Water Resources Board, no date) of potentially irrigable lands in the Flint Creek Valley, the areas that could be converted to irrigation are Class III lands. Class III lands have severe limitations because of soil properties, slope, and soil moisture conditions.

Class III lands may have severe limitations; however, it does not mean that they cannot be successfully irrigated. Mike Kaczamarek, an irrigation specialist at the engineering firm of Morrison-Maierle Inc., devised an irrigable soil

classification (see Appendix A) in which a separate "sprinkler class" was assigned to certain soils with one or more of the following limiting factors: 1) steep slopes, 2) high erosion hazard, 3) extremely slow permeability, 4) inadequate depth over very slowly permeable substrata, 5) very low moisture holding capacity, and 6) high alkalinity or salinity hazard. Sprinkler irrigation of slowly permeable soils in this class may not be designed to satisfy total crop evapotranspiration requirements but will still result in substantially increased yields over dryland methods.

III. IRRIGATION STATUS

The status of irrigated and arable lands[2] within the Upper Clark Fork drainage has been assessed by the Water Resources Board of the DNRC, the Soil Conservation Service (SCS), and to a limited extent the Energy Division of the DNRC. Although different criteria have been used to map arable lands, both the DNRC and the SCS have based their classifications primarily on the agronomic features of the soil rather than on water availability or cost/benefit ratios. The following sections describe the measures that have been taken to assess the status of irrigated lands within the Upper Clark Fork drainage by the DNRC (Water Resources Board and Energy Division) and the SCS.

A. Water Resources Division - DNRC

Glen Smith and other staff at the DNRC compiled a statewide map (1:125,000 scale) of irrigated lands and arable lands not currently under irrigation. The criteria for mapping these lands are attached as Appendix B. According to Earl Griffith, Earth Sciences Coordinator of the Energy Division (1984), the accuracy of the mapping of arable lands is probably less than 75 percent.

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[2]"Arable" land differs from "irrigable" land in that arable lands are those which have soil, climatic, and topographic features suitable for supporting sustained crop production. In order for lands to become "irrigable," water must be available and a suitable cost/benefit ratio must exist for supplying that water.

B. Soil Conservation Service

The draft soils survey for the Upper Clark Fork drainage has recently been completed (Tribelhorn 1984). Because the soil survey is still in draft form, it can only be used by visiting the SCS offices in Deer Lodge and Philipsburg.

Lands with potential for irrigation can be interpreted by using the SCS soil series delineations and applying the SCS Land Capability Classification (Soil Conservation Service 1961) criteria to these series. According to the Land Capability Classification,

> Arable soils are grouped according to their potentialities and limitations for sustained production of the common cultivated crops that do not require specialized site conditioning or site treatment.

Although the SCS Land Capability Classification system is not heavily weighted to reflect economic factors in agriculture, some economic aspects are integrated into the system. For example, it is assumed when a soil is placed in a capability classification, suitable for agricultural use, that a moderately high level of management is practical. Also, a favorable ratio of "output to input" is assumed based on long-term economic trends for average farms.

Rich Pederson (1984) of the SCS office in Philipsburg suggested that the SCS Capability Classification may not adequately provide a basis for determining potentially irrigable lands in the Flint Creek Valley because past economic considerations may not apply to the current economic climate of the area. Electric rates, for example, have and will continue

to inhibit expansion of irrigated acreage where pumping is required. However, if a dam were to be constructed in such a manner as to provide irrigation water through a gravity feed system, the economic feasibility of expanding irrigated acreage may become favorable.

C. Energy Division - DNRC

As part of the Energy Division's environmental analysis of the Bonneville Power Administration's (BPA) 500-kV Garrison-Spokane Transmission Line, irrigated lands were mapped in portions of the Flint Creek Valley. Irrigated lands were delineated on acetate overlays of 1:24,000 scale orthophoto quad maps. Although the entire Flint Creek Valley was not mapped, the irrigation status of those unmapped areas can be readily determined by additional field checking and interpretation of the photobase quad maps.

IV. HEAVY METALS

Contamination of soils by heavy metals in the Upper Clark Fork drainage is a problem which limits the production potential of some lands and may seriously impair water quality. Airborne heavy metal particulates have been emitted from the Anaconda Smelter since the late 1800s and have settled on the land in the Deer Lodge Valley. Additional waterborne mine tailings with high heavy metal concentrations have contaminated floodplain soils and some agricultural land in close proximity to the Clark Fork River. Heavy metals in soils impose constraints on various land uses including irrigated agriculture. The following studies have addressed the heavy metal problems in the Deer Lodge Valley or in the riverine ecosystem downstream.

A. MultiTech

The consulting firms of MultiTech and Stiller and Associates (1984) have contracted with the Montana Department of Health and Environmental Sciences (DHES) through the federally funded Superfund Program to prepare the Silver Bow Creek Remedial Investigation Work Plan. This plan describes the many problems in the Anaconda-Butte area associated with past mining and smelting activities and suggests means to ameliorate or better identify the problems.

MultiTech cites the work of various agencies and consultants and states:

> Just downstream of the Warm Springs Ponds, Warm Springs Creek and Silver Bow Creek converge to form the Clark Fork River. Warm Springs Creek is a high quality stream that is degraded in its lower reaches. The cause of the degradation is possibly a combination of seepage from AMC treatment ponds and irrigation de-watering (Casne and others 1975). Tailings deposits cover much of the floodplain of the upper Clark Fork and contribute unknown contaminants, via runoff, to the river. MDHES (1983) study found an increase in sulfate and total copper loads for the Clark Fork River from its origin to Deer Lodge. This increase is thought to be the result of impacts from floodplain and in-stream tailing deposits (Green 1984).
>
> Tributaries to the Clark Fork River along this reach are affected by some mining and agricultural activity. These lands may produce some contaminant loads to the Clark Fork River.

MultiTech additionally states,

> Soil contamination along the Upper Clark Fork River is nearly identical to that described for the canyon to Warm Springs Ponds river segments. A much greater extent of irrigated land is found along this portion of the Clark Fork. The downstream extent of significant contamination is presently indeterminate. Barren areas are common along the river point bars as far as Deer Lodge. It is expected that contamination could occur at least as far downstream as Garrison.
>
> The literature review in Section 9.4.2 documents the need for systematic identification and demarcation of those lands either known or suspected to be affected by "heavy metal" contaminated irrigation waters. Initially, those ditches that received surface waters diverted or pumped from either Silver Bow Creek or Upper Clark Fork River were identified. This effort was accomplished via review of the respective water resource surveys for Silver Bow (Buck et al. 1955a) Deer Lodge (Buck et al. 1955b), and Powell Counties (Buck et al. 1959). Secondly, those owners potentially affected were identified either through inspection of each county's land ownership (plat) books or interviewing knowledgeable Soil Conservation Service personnel in Deer Lodge (Tribelhorn and Dutton, personal communications). Thirdly, a news release was published on February 28, 1984 in the Montana Standard (Kemmick 1984) that included a solicitation for information pertinent to the irrigated lands study. The initial listing of persons that will be contacted are presented by soil conservation district in Appendix Table 9.5-5.
>
> A preliminary estimate of areal extent of affected lands totals to 5380 acres, for the three given counties. The respective county figures are as

> follows: Silver Bow, 0 acres; Deer Lodge, 1115 acres; and Powell, 4265 acres. Apparently, the combined municipal and industrial effluents discharged by Butte sources into Silver Bow Creek have prevented any attempts at using its water for regular or flood irrigation purposes (Buck _et al_. 1955a). The inclusion of the entire Deer Lodge Valley Conservation District seems appropriate, as waters from the Clark Fork River are pumped or diverted from it throughout this area. Furthermore, "heavy metal" contamination of ripariain vegetation by sediments has been documented in the vicinity of Drummond, Montana (Ray 1983). This town is located approximately 10 river miles west of the Granite County-Power County border, implying that transport of effluents has traveled (historically) at least this far downstream.

MultiTech's Appendix 9.5-5 ("Potentially Affected Landowners present within the Mile-High and Deer Lodge Valley Soil Conservation Districts") and Table 6-13 ("Derivation of the Estimate for Potentially Affected, Irrigated, Lands Present Within the Study Area") are attached as Appendix C.

A portion of MultiTech's proposed work plan concerns identifying more accurately those areas where heavy metal contamination of soils poses threats to health or agricultural operations. The details of the $93,000 proposed study are described in the Work Plan but the DHES has not yet determined whether all or a portion of the study will be funded. This determination will be made within the next month or two.

B. _University of Montana_

The Gordon Environmental Studies Laboratory of the University of Montana has recently completed studies on the Grant-Kohrs Ranch, a National Historic Site administered by the National Park Service, and on the floodplain of the Clark Fork

River between Rocker and Drummond. These studies were conducted to measure heavy metal concentrations in soils which are barren of vegetation or have plant communities indicative of heavy metal pollution.

Ray (1984) found elevated levels of copper, cadmium, and arsenic at all sites studied along the Clark Fork with some of the highest concentrations being present at Drummond, the site farthest from the source of the waterborne mine tailings. All of Ray's samples were collected on barren or sparsely vegetated areas which showed surficial evidence of waterborne sediment deposition.

Rice and Ray (1984) conducted a floral and faunal survey of the Grant-Kohrs Ranch National Historic Site. They found that the top 25 centimeters of soil on the Clark Fork floodplain had metal concentrations one or two orders of magnitude greater than the concentrations in the control samples. Only a small fraction of this contamination was attributed to deposition of airborne particulates during the period of smelter operation, 1884 through 1980. Deposition on the floodplain of toxic metal enriched sediments was determined by Rice and Ray to be the predominant and continuing mechanism of contamination.

C. Hydrometrics

The consulting firm, Hydrometrics, (1983) conducted long-term environmental rehabilitation studies in the Deer Lodge Valley under contract to the Anaconda Minerals Company.

Hydrometrics reported that milling and smelting operations at Butte and Anaconda have resulted in extensive but relatively thin tailings deposits on the floodplain. These deposits have killed riparian vegetation in numerous areas and have created barren or sparsely vegetated areas which resulted from past attempts to irrigate with poor quality water diverted from the Clark Fork River. Field reconnaissance and aerial photointerpretation were used to map approximately one million cubic yards of tailings (covering 1,250 acres) deposited on the floodplain between Warm Springs and Deer Lodge.

Hydrometrics also conducted soil tests in the Deer Lodge Valley. They found that soils with low pHs had sparse vegetation cover and that soil pH was inversely related to soluble metal concentrations. Downward percolation of metals from tailings and redeposition in the underlying alluvial soils has increased concentrations of copper, zinc, manganese, and sulfur to a depth of 24 inches at some sites.

D. <u>Soil Conservation Service</u>

The SCS in Deer Lodge has mapped some areas within the Deer Lodge Valley where toxic metals have affected plant growth and soil productivity. The SCS uses the term "slickens" to describe

> An undifferentiated soil type consisting of accumulation of fine-textured materials, such as are separated in placer-mine and ore-mill operations. Slickens from ore mills consist largely of freshly ground rock that commonly have undergone chemical treatment during milling or smelting processes.

SCS personnel are also aware of landowners who have problem soils or suspect that heavy metals have affected their agricultural operations.

E. Graduate Studies

Graduate students at the University of Montana conducted studies on vegetation and soils in the vicinity of Anaconda. Munshower (1972) studied cadmium compartmentation and cycling in grasses and soils of the Deer Lodge Valley and was able to construct isopols which linked areas of similar soil concentrations of cadmium. The isopol concentrations were attributed only to airborne deposition of particulates produced by the smelting of ore.

Other studies were conducted by Taskey (1970) and Hartman (1976). Taskey studied the contamination of soils around Anaconda by airborne heavy metals, whereas Hartman studied the influence of heavy metals on the fungal flora of the soil.

IV. IDENTIFICATION OF IRRIGABLE LANDS

It is necessary to evaluate water allocation requests in the Upper Clark Fork to determine which lands are "irrigable" as opposed to those that are "arable." The irrigable status of lands must be determined based on soil factors, climate, and topography as well as on water availability and economics. It is relatively straightforward to categorize arable lands based on soil and climatic factors. In contrast, it is more difficult to devise general criteria that apply to water availability and cost that can be applied over a broad resource area.

Oellerman (1983) analyzed economical pumping elevations in the Yellowstone Basin and found that the preliminary economic criteria for irrigability included only lands within three miles and 450 feet of the water source. Through a computerized analysis it was found that 93 percent of those lands which met the preliminary criteria had to occur within 100 feet elevation of the pumping source to be irrigated with economic feasibility.

Oellerman discussed that as the economy changes, the economics of pumping lift distances will also change. He did, however, believe that the methodology he outlined was sound and should be considered for use in any future calculations of practicably irrigable acreages.

Given the fact that electricity rates for irrigators will rise substantially in the near future, it is necessary to

consider the economics of gravity feed systems such as those envisioned by the Granite County Conservation District. Pumping costs might economically rule out all but a low cost gravity feed system; however, because the Granite County projects are designed to impound moderate sized streams, the high costs associated with spillway construction to handle probable maximum floods may prove to create an undesirable cost/benefit ratio.

Based on reviews of the methods used to assess potential irrigability of lands, it appears that most methods do not rely on economic criteria which can be routinely applied over a large geographic area. Most economic analyses have to be made on a site-specific or project-by-project basis to account for the many variables encountered. Due to the apparent small number of proposed or feasible projects to expand irrigation or increase water availability in the Upper Clark Fork drainage, it appears to be practical to consider the economic viability on a project-by-project basis. Therefore, it is recommended that those arable lands which would be affected proposed irrigation projects be considered as potentially irrigable unless an economic analysis proves otherwise.

When considering the data in the Water Conservation and Salvage Report for Montana (Soil Conservation Service 1978), it appears that improved delivery and use of irrigation water can be expected with improving technology. According to the Salvage Report, only one irrigated acre in ten has an adequate

water supply, conveyance system, on-farm system, and return system, and receives good irrigation water management. Currently, about 4.9 acre-feet are diverted for every acre-foot used by crops but by the year 2000 efficiency is expected to increase so that 2.9 acre-feet will be diverted for each acre-foot used by crops. This improvement in efficiency, coupled with the development of additional late season storage, is expected to meet the future water demands of existing irrigated lands with the exception of waterspreading systems. Without adequate water available for existing lands, it appears somewhat infeasible to expand the irrigable land base. Improving efficiencies appears to be a means whereby existing lands may receive additional water but even with improved efficiencies it does not appear that there will be adequate water to allow expansion of the irrigable land base much beyond its current acreage.

In addition to economic constraints to expanding the irrigated land base, there are constraints imposed by toxic metal concentrations in soil. Toxic metals are often relatively immobile in soils because they form chemical complexes with organic materials, clays, manganese and iron oxides, and calcium carbonate. Because of the tendency of heavy metals to form insoluble complexes, most of the metals deposited by air and water remain in the upper soil horizons where they pose the greatest impact on plant growth and are available for ingestion by livestock.

Expansion of the irrigated land base into areas of the Deer Lodge Valley or on terraces of the Clark Fork River which have been contaminated by heavy metals does not appear to be an environmentally sound practice. Tillage of land could reduce the organic content of the soil and, consequently, release previously bound toxic metals. Tillage could also bring low pH soils to the surface. Because low pH favors increased metal solubility, application of irrigation water and return of contaminated water to the Clark Fork could increase the metal levels in the Clark Fork. Additionally, some crops accumulate heavy metals and may become hazardous for human or livestock consumption if grown on contaminated sites.

Considering the heavy metal constaints, it is recommended that no lands which are not now being irrigated in contaminated areas of the Deer Lodge Valley or along the Clark Fork River be brought under irrigation. Areas of contamination should be determined by studying existing data. Moreover, because the Superfund Program is focusing on the problem of heavy metal effects on agriculture, it is recommended that close coordination be maintained with DHES (Mike Rubich) to avoid duplication of effort.

V. SUMMARY

The following course of action is recommended to complete the next tasks for this project:

1) Update existing maps of irrigated lands by using current SCS photography and through on-the-ground reconnaissance.

2) Consider those lands which are not currently being irrigated as being irrigable if they would be affected by a proposed irrigation project.

3) Coordinate closely with the Superfund Program to identify lands within the Deer Lodge Valley that are contaminated by heavy metals.

4) Through use of SCS photos and field reconnaissance, determine areas along the Clark Fork River which may be contaminated by heavy metals.

5) Consider collecting and analyzing soil samples along the Clark Fork River for determination of heavy metal concentrations. Lands between Drummond and Bearmouth would be the most extensively sampled due to the paucity of data within this reach of the river. In addition, extensive areas of dead riparian vegetation occur along this reach.

6) Determine which lands currently being irrigated within the Upper Clark Fork Valley have adequate irrigation water supplies. If adequate or surplus water is currently available for existing irrigation, study adjacent unirrigated

arable lands for the feasibility of expanding the irrigated land base.

7) Determine whether off-stream storage potential exists for any sites within the Upper Clark Fork Valley. The economic feasibility increases for off-stream storage; therefore, arable lands that could be irrigated from such impoundments should be studied to determine the potential for expanding the irrigated land base.

SOURCES OF INFORMATION

SOURCES OF INFORMATION

Griffith, E., Earth Sciences Coordinator, Montana Department of Natural Resources and Conservation. Personal communication to Joe C. Elliott, Ecological Consultant (June 12, 1984).

Guehlstorff, K. 1984. Montana Water Use. Montana Department of Natural Resources and Conservation. (In press)

Hartman, L. 1976. Fungal Flora of the Soil as Conditioned by Varying Concentrations of Heavy Metals. Ph.D. Dissertation, Botany Department, University of Montana, Missoula, Montana.

Hydrometrics. 1983. Summit and Deer Lodge Valleys Long-Term Environmental Rehabilitation Study, Butte-Anaconda, Montana. Vol. IX, Anaconda Old Works and VIII Opportunity Ponds. Submitted to the Anaconda Mineral Company, Butte, Montana.

Montana Water Resources Board, Montana Department of Natural Resources and Conservation. No date. Maps prepared of irrigated and irrigable lands in Montana by Glen Smith and others.

MultiTech and Stiller and Associates. 1984. Silver Bow Creek Remedial Investigation Work Plan. Submitted to the Solid Waste Management Bureau, Montana Department of Health and Environmental Sciences.

Munshower, F. 1972. Cadmium Compartmentation and Cycling in a Grassland Ecosystem in the Deer Lodge Valley, Montana. Ph.D. Dissertation, Botany Department, University of Montana, Missoula, Montana.

Oellerman, D. 1983. Memo from Doug Oellerman, Hydrologist, Montana Department of Natural Resources and Conservation, to Scott Brown, Program Manager, Reserved Water Rights Compact Commission. Regarding: Analysis of economical pumping elevations in the Yellowstone Basin.

Oellerman, D., Hydrologist, Montana Department of Natural Resources and Conservation. Personal communication to Joe C. Elliott, Ecological Consultant (June 21, 1984).

Pacific Northwest River Basins Commission. 1971. Columbia-North Pacific Region. Comprehensive Study of Water and Related Lands, Appendix IX. Vancouver, Washington.

Pederson, R., District Conservationist, Soil Conservation Service, Philipsburg, Montana. Personal communication to Joe C. Elliott, Ecological Consultant (June 14, 1984).

Ray, G. 1984. Toxic Metal Enrichments from Mining and Smelting Operations in Riverside Sediments of the Upper Clark Fork. Presented to the Northwest Scientific Association and Montana Academy of Sciences Conference, Missoula, Montana.

Rice, P. and G. Ray. 1984. Floral and Faunal Survey and Toxic Metal Contamination Study of the Grant-Kohrs Ranch National Historic Site. Report to the National Park Service. Contract No. CX-1200-2-B044.

Soil Conservation Service. 1961. Land-Capability Classification Agricultural Handbook. No. 210, U.S. Department of Agriculture.

Soil Conservation Service. 1978. Water Conservation and Salvage Report for Montana. U.S. Department of Agriculture, Portland, Oregon.

Taskey, R. 1970. Soil Contamination at Anaconda, Montana: History and Influence on Plant Growth. M.S. Thesis, School of Forestry, University of Montana, Missoula, Montana.

Tribelhorn, B., District Conversationist, Soil Conservation Service, Deer Lodge, Montana. Personal communication to Joe C. Elliott, Ecological Consultant (June 11, 1984).

APPENDIX A

IRRIGABLE SOILS CLASSIFICATION CRITERIA FOR
NORTHERN MONTANA RECONNAISSANCE CLASSIFICATION

Characteristics	Class 1 Slight Limitations	Class 2 Moderate Limitations	Class 3 Severe Limitations	Sprinkler Class
SOIL PROPERTIES				
Effective Soil Depth 1/				
Nonrestrictive Substrata 2/				
Bounded as follows:				
a. Unconfined Drainage	40 inches minimum	20 to 40 inches	10 inches minimum	10 inches minimum
b. Nonsaline Barrier	96 inches minimum	72 to 96 inches	60 to 72 inches	60 inches minimum
c. Saline Barrier	120 inches minimum	96 to 120 inches	96 inches minimum	96 inches minimum
Restrictive Substrata 3/				
Bounded as follows:				
a. Unconfined Drainage	40 inches minimum	20 to 40 inches	10 inches minimum	10 inches minimum
b. Nonsaline Barrier			240 inches minimum	60 inches minimum
c. Saline Barrier			240 inches minimum	120 inches minimum
Soil texture range in root zone	Loamy very fine sand to friable clay loam.	Loamy sand to permeable clay.	Loamy sand to slowly permeable clay. Very fine to medium sands with sufficient AMHC are included.	Same as Class 3
Permeability of undisturbed soil (inches/hour) 4/	Moderately slow to moderate (0.20-2.00 inches/hour)	Slow to moderately rapid (0.06-6.00 inches/hour)	Very slow to rapid (Less than 0.06 to 6.5 inches/hour)	Very slow to rapid (Less than 0.06 to 8 inches/hour)
Available moisture holding capacity (inches/48 inch depth)	8 inches minimum	6 inches minimum	4 inches minimum	2 inches minimum

1/ Effective soil depth includes both the solum and self draining or artificially drained substrata. Criteria shown here are for average anticipated soil permeability, internal drainage, and saline/alkali conditions.

2/ Nonrestrictive substrata are moderately slow to rapid draining materials including alluvial sands, sand and gravel, and other self draining alluvial and colluvial parent materials.

3/ Restrictive substrata are very slow to moderately permeable materials including shallow geologic substrata such as sandstone and siltstone as well as very slowly self draining surficial deposits such as glacial till and fine-grained alluvial and colluvial silty and clayey sediments.

4/ Permeability may exceed values shown if sufficient available moisture holding capacity (AMHC) is present in upper 48 inches of soil.

Characteristics	Class 1 Slight Limitations	Class 2 Moderate Limitations	Class 3 Severe Limitations	Sprinkler Class
Salinity expressed as electrical conductivity (E.C.) in millimhos/cm.	4 millimhos/cm maximum under average drainage conditions. 8 millimhos/cm maximum in top 48 inches where good leaching and drainage conditions exist.	4 to 8 millimhos/cm. E.C. in an individual horizon may exceed 8 millimhos/cm under good leaching and drainage conditions. Most horizons will have less than 8 millimhos/cm.	8 millimhos/cm maximum in top 24 inches. Maximum of 15 millimhos/cm tolerable at depths below 24 inches only if adequate leaching and drainage conditions exist.	Same as Class 3
Alkalinity 5/	Soil reaction neutral (pH 6.6-7.3) and organic content low.	Soil reaction neutral to moderately alkaline (pH 6.6-8.4); calcareous horizons present, and organic content low.	Soil reaction mildly to moderately alkaline (pH 7.4-8.4); no calcareous horizon present, & organic content low. If soil reaction is strongly alkaline or greater (pH 8.5 to over 9.0), a severe sodic condition probably exists regardless of calcareous horizons or organic matter content.	Same as Class 3
Permissable Coarse Fragments: (% by vol.) 6/	No problem in tillage	Moderate problem in tillage	Severe problem in tillage	Same as Class 3
Gravel (1.0-3.0")	15% maximum	15 to 55%	55 to 70%	
Cobble (3.0-10.0")	5% maximum	15% maximum 7/	15 to 35% 7/	

5/ These criteria are not independently sufficient to determine the alkalinity hazard of a soil; however, they are suggested here as a general interpretive tool in evaluating the SCS data which does not contain exchangeable sodium percentages or sodium adsorption ratio data. Criteria for sodium hazard presented here assume reasonably good leaching and drainage conditions (with or without artificial drainage).

6/ Criteria is intended to assess factors limiting tillage. In practico, available moisture holding capacity may become the actual limiting factor before tillage is affected as coarse fragments percent increases.

7/ May be higher % in subsoil for certain shallow rooted crops if surface soil is favorable. Limitations may be reduced somewhat in surface soil by use of modern rock-picking equipment.

Characteristics	Class 1 Slight Limitations	Class 2 Moderate Limitations	Class 3 Severe Limitations	Sprinkler Class
Rockiness (Proportion of nonsaline bedrock outcrops and shallow nonsaline bedrock).8/	No bedrock exposures or too few to interfere with tillage. Less than 2% bedrock exposed.	Bedrock exposures interfere with tillage but cultivation is practicable. Rock exposures are 100-300 ft. apart and cover 2-10% of surface.	Same as Class 2	Same as Class 2
Soil Erosion	Severely eroded soils will be downgraded one class. Moderately to slightly eroded soil phases may be downgraded on a judgement basis, depending on associated conditions.			
TOPOGRAPHY				
Slope9/	0-4%	4-8%	8-15%10/	0-15%
Stone Removal11/	No stones or too few interfere with tillage. Stones cover less than 0.01% of the area.	Sufficient stones to interfere with tillage but not to make cultivation impracticable. Stones cover 0.01-0.1% of surface and require removal of 0.15 to 1.5 cubic yards per acre for up-grading.	Too stony for practical sustained cultivation. Land can be worked for hay or improved pasture if other soil conditions favorable. Stones cover 0.1-3.0% of surface and require removal of 1.5-50.0 C.Y./Acre for up-grading.	Same as Class 3
DRAINAGE				
Water table (during growing season with or without drainage)	Easily maintained below 60 Inches.	Can be maintained between 40 to 60 inches during most of the growing season (may require artificial drains).	Can be maintained below 40 inches during most of the growing season. (May require artificial drains).	Same as Class 3

8/ No more than 2% saline bedrock outcrops is tolerable in any soil class. The presence of 2% or less saline bedrock outcrops is indicative of inadequate soil depth over a saline substrata or barrier.

Heavy textured soils in the slope range of 2-4% may be downgraded to Class 2 where an erosion hazard exists under flood irrigation management.

10/ Sprinkler irrigation on slopes greater than 8%.

11/ Land may be upgraded by removal of stones.

Characteristics	Class 1 Slight Limitations	Class 2 Moderate Limitations	Class 3 Severe Limitations	Sprinkler Class
Depth to Drainage Barrier 12/	8 feet minimum	5-6 feet minimum	5-6 feet minimum	5 feet minimum
Saline Seep Hazard	This item can only be inferred from general geologic, soils, and groundwater relations until sufficient data is accumulated to determine barrier surface topography and groundwater movements.			
Surface Drainage	Good	Good	Restricted	Restricted
Overflow	No overflow	Free of overflow in growing season.	Overflow hazard to crops in 2 or 3 years out of 10.	Same as Class 3

CLIMATE (Growing season to be established separately for specific areas within the region).

12/ Corresponds to soil depths for soils on slowly permeable substrata or non-saline barrier. This may vary somewhat in practice according to soil and substrata permeabilities.

CLASS 3: SEVERE LIMITATIONS. Soils in this irrigable soil class have more limitations than those in Class 2 and require intensive management of irrigation practices including use of artificial drainage in some cases. These soils will grow the same types of crops as Class 1 and 2 soils; however, restrictions in kinds of crops or use of selective cropping combinations may be desirable due to soil limitations. Factors resulting in limitations in the use of soils in Class 3 include: (1) moderately steep slopes, (2) high erosion hazards, (3) very slow permeability, (4) shallow soil depth and restricted root zone, (5) low water-holding capacity, (6) shallow water table, (7) moderate alkali or salinity hazards, and (8) unstable soil structure.

SPRINKLER IRRIGATION CLASS: Soils in this irrigable soil class are restricted to sprinkler irrigation management due to one or more of the following limiting factors: (1) steep slopes, (2) high erosion hazard, (3) extremely slow permeability, (4) inadequate soil depth over very slowly permeable substrata, (5) very low moisture holding capacity, and (6) high alkalinity or salinity hazard. Where sprinkler irrigation of soils in this class is not feasible, these soils will be reclassified as nonirrigable. Sprinkler irrigation of slowly permeable soils in this class may not be designed to satisfy total crop evapotranspiration requirements but will still result in substantially increased yields over dryland methods.

APPENDIX B

MONTANA WATER RESOURCES BOARD
LAND RESOURCES SECTION
DESCRIPTION OF THE LAND CLASSIFICATION DATA PROCESSING SYSTEM

The data presented herein is a summary of tabulations of presently irrigated and potentially irrigable land, compiled by township, range, and section within each county and drainage basin in Montana.

The land classification surveys are made to establish the degree of suitability of land for sustained irrigation farming. The objective is to outline the land areas and tabulate the acres that have a potential for irrigated agriculture.

The Montana Water Resources Board land classification is of a general reconnaissance survey intensity. Any future irrigation project development should be based on a detailed study to pin-point the exact location and limits of the land best suited for irrigation.

The term "irrigable land" as used in this classification includes land which will support sustained irrigated agriculture because soils, topography, drainage features, and climate are suitable for irrigation by gravity or sprinkler methods. Irrigable lands are divided into classes on the basis of their relative suitability for irrigation farming. Class 1 represents irrigable land with potentially high productive value; class 2 represents land of intermediate value; and class 3 includes land of the lowest value that may be considered suitable for irrigation; class 3C lands are restricted by climatic factors.

Class 6, "non irrigable", is land that will not economically support sustained irrigated agriculture.

Classes 1, 2, 3, and 3C are totaled by the computer to produce a total "Irrigable" figure which when added to the "Irrigated" acreage and subtracted from the "Total" number of acres in the section, township, or county, produces the figure under "Class 6" land. These figures are then totaled vertically to produce a township (and range) subtotal and those figures total to produce a county total.

Although the information in this book is summarized by counties as per the code sheet at the right, it is also possible to summarize the data by river drainage basin--using the code number which appears in the right-hand margin of the summary listing sheets.

In using the summary sheets, all townships appear in ascending order with north townships preceding south townships of the same number, i.e. 02N precedes 02S.

East and west range designations appear following the township designations with all east ranges of one township preceding all west ranges of the same township, i.e. 02N01E precedes 02N01W.

Section designations follow the range designation in ascending order and vary in number from 1 to 36.

The standard number of acres per section is 640. This number varies considerably either way, however, and may range from as little as 320 acres to as many as 800 acres.

MEMORANDUM

January 16, 1979

TO: Edward F. Miller, Chief
Technical Services Bureau

FROM: Glenn R. Smith, Supervisor, Soils Section
Technical Services Bureau GRS

SUBJECT: Types of Irrigated Acres by Water Supply, Joint Study with Bureau of Reclamation.

The irrigated acres of the DNRC land classification were determined for the purpose of adding maximum acreage to Montana's irrigated agriculture. The emphasis being that if an acre of land is receiving water beneficially by man's control by constructing dikes, diversions, ditches, etc., it is counted as irrigated. Primarily this system was used to map the irrigated acres in the Water Resources Survey publications dated from 1946 to 1973 in Montana. The only mapped acres of irrigated land is the Water Resources publications. Therefore, the base acres of the land classification are from the survey maps. In 1975 the irrigated acres were checked in the Upper Missouri from tributaries to main stem downstream to the Cascade-Chouteau County line. The Sun River was checked in Lewis and Clark County and Cascade County. The new irrigated areas were added to the county land classification maps. The area from Cascade-Chouteau County line to the North Dakota line was mapped by a flyover which added only Center Pivot irrigation. There were about 56 circles added.

The problem of how much water these lands are receiving is critical and always has been a question because no effort has ever been put into the hydrology of the area. The Upper Missouri Level B Studies should consider at least three different water alternatives: The first group is full water supply irrigated acreage which receives diverted water from main stem rivers, Beaverhead, Big Hole, Jefferson, Madison, Gallatin, Missouri and Marias. The irrigated land which is supplemented by stored water should also be included in the first acreage group. Also, some creeks which have small irrigated acreage and good water supply are in the first group, an example is Belt Creek in Cascade County. The majority of Gallatin County irrigation is in the first group because of difficulty in breaking the acres out into other groups and also the abundant water supply.

The second irrigated acreage group is partial water supply acres. In the Upper Missouri Area there are many streams which run heavy during spring and moderate until the middle of July, then critical low flows for the remainder of the irrigation season. The irrigated crop land receiving water from these streams is mainly grain, alfalfa, and large acreages of native hayland. The consumptive plant use, diversion of irrigation water, and fisheries diminish in later summer. Storage reservoirs of any size are not present in the second irrigation group.

The third irrigated acreage group is the critical water supply. The irrigated acres are mainly alfalfa and native hayland. The yields are low because of water supply. However, they are higher than dryland. The irrigation of these areas are mainly spreader dike systems or small diversions which receive water once from spring runoff. The majority of the acres are in Northeastern and Central Montana prairie lands.

The methodology used to determine the acreages for the three groups is not complicated. The Water Resources Survey publications show irrigated acres by

stream basins. The major stream is near margin edge of the sheet, and the tributaries are identified on the left hand margin which indicates that they are tributaries of the first stream named above which is not indented.

The acres shown by each stream is tabulated and if the stream is major, as with storage the acres are full water supply.

If the water supply is from early spring to the middle of July the acres are under partial water supply. The book information may note the limited water supply by decrees, or gauging stations. Also the knowledge of a long time hydrologist and my field observations helped determine if the area is partial water supply.

The tributary streams originating in prairie lands are critical water supply which irrigation is generally spreader dike or similar diversions. These acres are in critical or spreader dike column.

The Bureau of Reclamation and Chief of the Missouri Level B Study have met with us. They are cooperating on this study. The tabulated acreages are being sent them for their review. I suggest that any other irrigated acre water supply studies consider this technical report and U.S. Bureau of Reclamation review. The drainage basins acreages from the Upper Missouri tributaries to the mouth of the Marias River, including the Marias basin have been sent to the Bureau of Reclamation for their review and studies.

GRS/lh

Pencil attachments enclosed

cc: Gary Fritz
Larry Brown
Ron Thompson
Derwood Mercer, U.S.B.R.

STATE WATER PLAN

MONTANA WATER RESOURCES BOARD - LAND CLASSIFICATION SECTION

Soil or Land Characteristics	Class 1* Only Slight Limitations	Class 2* Moderate Limitations	Class 3 Severe Limitations
Dominant texture of Root Zone	Fine sandy loam to friable clay loam	Loamy sand to permeable clay	Loamy sand to clay (sands with sufficient w.h.c. can be included.)
Depth to: Clean sand, gravel and cobble	40" minimum	20" minimum	10" minimun
(A) Hard rock, Sandstone or non-saline Shale	60" minimum	40" minimum	30" minimum
Textural Modifers			
(Vol.) of tillage layer: Gravel (<-3") Cobble (3-10")	No problem in tillage < 15%	Moderate problem in tillage 15 to 50% <-3" < 15% (3-10")	Severe problem in tillage > -50% <-3" 15 to 50% 3-10"
(B) Stoniness of surface and tillage layer, stones generally greater then 12" in diameter.	No problem in tillage	Cultivation not impractical. Stones >12" diameter; occupy 0.01 to 0.1% of the surface, and 0.15 to 1.5 cubic yards per acre foot.	Cultivation impractical unless cleared. Stones >12" diameter; occupy 0.1 o 3% of the surface, and 1.5 to 50 cubic yards per acre foot.
(B) Rockiness (Small outcrops within Soil type)	No problem in tillage Less than 2% of bedrock exposed.	=2% of surface may have bedrock exposed	2 to 10% surface may have bedrock exposed

In areas where use has demonstrated suitability, more severe modifiers can be rated irrigable for special uses not requiring tillage.

Soil or Land Characteristics	Class 1* Only Slight Limitations	Class 2* Moderate Limitations	Class 3 Severe Limitations
Available water-holding capacity (to a maximum depth of 4 feet)	> 6"	> 4"	> 2"
Permeability	Moderately slow - .20 inches per hour to moderate - 2.00 inches per hour, may exceed 2 inches per hour if sufficient water holding capacity is maintained - by field observation of soil texture, structure, etc.	Slow - .06 inches per hour to moderately rapid - 2.00 to 6.30 inches per hour - by field observation of soil texture, structure, etc.	Very slow - less than .06 inches per hour only in thin layers. To rapid - greater than 6.30 inches per hour if upper lift of soil has sufficient water holding capacity - by field observation of soil texture, structure, etc.
Salinity and/or Alkalinity	Electrical conductivity not to exceed 4 millimhos/cm. may be higher under good leaching and drainage conditions. But not to exceed 8 millimhos/cm in top 4 ft.	Electrical conductivity not to exceed 8 millimhos/cm; except under good leaching and drainage conditions. Most horizons will have less than 8 millimhos/cm.	Electrical conductivity not to exceed 8 millimhos/cm in top 2 feet. Lower horizons may be higher under good leaching and drainage conditions, but not to exceed 15 millimhos/cm.

Slight or moderate salinity or alkalinity may exclude soils from Classes 1 thru 3 if associated with either or both a slow permeable substrata, or ~~s~~aline Shale. Exchangeable Sodium greater than 3.0 millequivalents per 100 grams and/or Sodium adsorption ratio greater than 12 of soil for cation exchange capacities less than 25 millequivalents per 100 grams - may exclude a soil from irrigable class if leaching is not practical.

Soil or Land Characteristics	Class 1* Only Slight Limitations	Class 2* Moderate Limitations	Class 3 Severe Limitations
	Topography B		
Slope	0-4%	< 8%	15% (Sprinkler irrigation on slopes > 8%)
	Drainage A		
(C) Water Table	Easily maintained below 5' depth during growing season.	Practical to maintain below 40" depth most of the time in growing season (requires drainage)	Can maintain below 20" most of the growing season.
Overflow	No over flow	Free of overflow in growing season	Overflow may be hazard to crops in some years (2 or 3 in 10)
	Climate A		
	Growing season greater than 90 days.	Growing season greater than 90 days.	Growing season may be less than 90 days.

Footnotes:

*Any one deficiency below the limits of a class is cause for downgrading to next lower class. Two or more ~~such~~ such deficiencies may cause downgrading two classes if judgement indicates they are additive in effect. Combinations of less severe deficiencies will be evaluated on a judgement basis.

(A) Soils known to be underlain by Saline-Shale at depths as shallow as 60 inches are excluded from Class 1 through 3.

(B) For detailed description see Soil Survey Manual U.S.D.A. pp 217 & 220.

(C) Applicable only if soils in Classes 1 through 3 are permeable enough to permit leaching of salts when drainage is provided

4

The basic assumptions that are being proposed for consideration in the land classification study are:

1. Assume that all future development will be sprinkler irrigation or surface methods with an efficiency equivalent to sprinklers.
2. Irrigable land classes can be lowered due to climate, but not entirely eliminated; mountain-meadows are being irrigated for hay production and should be considered as Class 3 land.
3. The exclusion of acreages due to future development of canals, roads and other right-of-way development within an arable area will amount to a six percent reduction.
4. The exclusion of acreages near expanding towns, cities and suburban areas will vary according to local conditions.
5. The land classification will be a basic general reconnaissance inventory to determine the suitability of land for future irrigated agriculture regardless of the water supply.
6. The given land class of any area will be the dominant class and areas containing less than 100 acres of a higher or lower land class may be present within a delineated boundary line. The office map size will be 1: 125,000. Map size for reports will be less than 1: 125,000 and the minimum acreage size will be greater than 100 acres in size.
7. The reconnaissance land classification is general and broad assumptions may be necessary in areas where little soil information is available; the survey should not be considered adequate for a detailed project plan. Large areas of detail soil surveys will be shown on the maps, however, the areas where broad assumptions are made will not show small areas of soil surveys.
8. The Land Classification Standards are considered as a guide and local conditions will sometimes vary from them.

STATE OF MONTANA

DEPARTMENT OF NATURAL RESOUCES AND CONSERVATION

TED SCHWINDEN
GOVERNOR

Memorandum

TO: THE MAP READER

FROM: Bob Ebert, Draftsman
Cartographic Bureau

DATE: July 27, 1983

SUBJECT: Land Classification

In some instances on the land classification maps in this file, a parcel of land or portion thereof will appear in a different drainage basin than the one it is tabulated to be in. This is due to a basin-line discrepancy, as the lines were projected from the following source of unsectionalized maps:

Atlas of Water Resources of Montana
by Hydrologic Basin

EXPLANATION
LAND CLASSIFICATION FOR POTENITAL IRRIGATION PLANNING
WATER RESOURCES DIVISION
of the MONTANA
DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

INTRODUCTION

The major features that determine the desirability of an area for irrigation development are the type of soil, topography, availability and quality of irrigation water, and the climate and markets. Soils and topography together with frost free season and mean temperature largely determine the ability of an area to produce, assuming that a dependable water supply is available, and finally a market is necessary to obtain a profit from crops that are produced. This land classification is based on a long-range projection that disregards the present available water supply for irrigation and market factors of crops produced.

Land classification is the process by which soils topographic relief, and climate are systematically appraised and lands are placed in categories based on similarity of characteristics. Land classification surveys made by the Water Resources Division of the Montana Department of Natural Resources and Conservation are specifically designed to establish the degree of suitability of land for sustained irrigation farming. The objective is to outline the land areas that have a potential for irrigated agriculture. Because technological advances in irrigation are taken into account, slope and surface topography become less important as rapid expansion of sprinkler irrigation takes place.

The land classification survey separates the land areas into (1) lands having potential for irrigation termed "irrigable" in contrast to (2) the inferior "nonirrigable" lands which are unsuited for present or future irrigation because of unfavorable characteristics. The term "irrigable land" as used in this

reconnaissance classification indicates land with soils topography and drainage features that are suitable for irrigation by gravity or sprinkler methods.

Lands classed as "irrigable" have soil, topography and climate that may support sustained irrigated agriculture however, further water management, drainage and detailed land classification studies needs to be conducted.

Lands that are classified as "irrigable" are divided into classes on the basis of their relative suitability for irrigation farming. Class 1 represents irrigable land with potentially high productive value; class 2 represents land of intermediate value; and class 3 includes land of the lowest value that may be suitable for irrigation.

The intensity of this land classification is a general reconnaissance survey. <u>Any future project development should be based on a detailed study</u> to pinpoint the exact location and limits of the land best suited for irrigation.

APPENDIX C

TABLE 9.5-5.--POTENTIALLY AFFECTED LANDOWNERS PRESENT WITHIN THE MILE-HIGH AND DEER LODGE VALLEY SOIL CONSERVATION DISTRICTS (CONTINUED)

PART B. DEER LODGE VALLEY SOIL CONSERVATION DISTRICT (DEER LODGE AND POWELL COUNTIES) (CONTINUED)

Landowner(s) Name(s)	Address/Phone No.	Comments
Fergeson, Harry (M.D.)	Opportunity/797-3707	Concerned about tailings contamination of Silver Bow and Mill Creeks.
FFA Farm, Powell Co. High School	Missouri and Claggett/ 846-2757	Utilize groundwater, and possibly divert surface (River) water.
Forsen, Dick	S of Deer Lodge/846-1449	Utilizes both groundwater and diverted River water; has expressed concern about tailings deposited on his land.
Fries, Orville	110 Eastside Rd./846-3514	Utilizes at least groundwater for irrigation purposes.
Gilman, Marlin	W. of Garrison/846-1514	Diverts water from the River, and serves on the ASCS Advisory Committee.
Hogan, Sam	Gold Creek/288-3491	None
Hollenback, John	Gold Creek/288-3382	Serves on the SCS Conservation District Advisory Board.
Indreland, R. E.	602 Milwaukee/846-2456	Very familiar with the history of irrigation in the Deer Lodge Valley.
Jacobson, Bud and Edna	1120 Yellowstone Trail/ 693-2379	Contact at the First Security Bank/ 846-2300 (Deer Lodge).
Johnson, Allen P.	481 North Frontage Rd./ 846-1832	Directs water from the River in the vicinity of Grant Kohrs Ranch; serves as the agent for the Kohrs-Manning Irrigation Group.

TABLE 9.5-5.--POTENTIALLY AFFECTED LANDOWNERS PRESENT WITHIN THE MILE-HIGH AND DEER LODGE VALLEY SOIL CONSERVATION DISTRICTS (CONTINUED)

PART B. DEER LODGE VALLEY SOIL CONSERVATION DISTRICT (DEER LODGE AND POWELL COUNTIES) (CONTINUED)

Landowner(s) Name(s)	Address/Phone No.	Comments
Johnson, Bill	E. of Deer Lodge/846-1603	None
Johnson, Eric	E. of Galen/693-2312	Pumps and diverts water from the River to irrigate large tracts of land.
Kelly, Jack Jr.	791 Yellowstone Trail/ 846-3269	Mrs. (Tony) Kelly is active in smelter-related impact assessment concerns, and is a good source of information on this subject matter.
Kelly, Ron	350 Greenhouse Rd./ 846-3825	Alfalfa crop is analyzed (at least for protein content) each year; can be reached also at the First Security Bank/846-2300 (Deer Lodge).
Kellicut, Skip	E. of Racetrack-Warm Springs/693-2327	Has submitted soil samples to MSU for arsenic analysis; can also be contacted at the First Security Bank/846-2300.
Lampert, Hans	200 East Side Rd./ 846-1786	Owns large tracts of bottom lands, and has expressed concern over tailings contamination of crops.
Launderville, Gary J.	971 Race Track Rd., Warm Springs/693-2365	Pumps water from recently installed wells.
Little, David	Jens/288-3832	None

TABLE 9.5-5.--POTENTIALLY AFFECTED LANDOWNERS PRESENT WITHIN THE MILE-HIGH AND DEER LODGE VALLEY SOIL CONSERVATION DISTRICTS (CONTINUED)

PART B. DEER LODGE VALLEY SOIL CONSERVATION DISTRICT (DEER LODGE AND POWELL COUNTIES) (CONTINUED)

Landowner(s) Name(s)	Address/Phone No.	Comments
Long, Huey	900 Milwaukee Av./ 846-3765	Concerned with soil/crop contamination by tailings; can be reached also at the USDA SCS Office/846-1703 (Deer Lodge).
Lowery, Alfred & Mary	430 Greenhouse Rd./ 846-2781	May have affected lands (from past irrigation with contaminated River water).
Montana Department of Fish, Wildlife, and Parks (MDFWP)	Contact Bob Greene/ 693-2262	The MDFWP uses water from Warm Springs Settling Pond No. 3 to irrigate several tracts of barley (to the east of the ponds) for waterfowl feeding.
Mosier, Bill Jr.	371 Freeze Out Lane/ 846-2828	A major consumer of water from the Kohrs-Manning Ditch; also is a Supervisor for the Deer Lodge Valley Conservation District.
Murphy, William	471 Warm Springs Creek Rd./846-2625	Pumps water from the River; serves also on the ASCS Advisory Committee
Olsen, Lars	N of Deer Lodge/846-2643	Probably diverts water from the River.
Opportunity Community Pasture	Contact Don Hewitt/ 797-3704	Ground water is utilized by cattle; Dave Streufert, County Extension Agent (Deer Lodge) has taken soil samples in the area.
Perkins, Jack	1472 Perkins Rd./846-1365	Some of his properties may have received aerial deposition of "heavy metals" emitted from the smelter stack. Serves as a Supervisor for the Deer Lodge Valley Conservation District.

TABLE 9.5-5.--POTENTIALLY AFFECTED LANDOWNERS PRESENT WITHIN THE MILE-HIGH AND DEER LODGE VALLEY SOIL CONSERVATION DISTRICTS (CONTINUED)

PART B. DEER LODGE VALLEY SOIL CONSERVATION DISTRICT (DEER LODGE AND POWELL COUNTIES) (CONTINUED)

Landowner(s) Name(s)	Address/Phone No.	Comments
Peterson, Wendell	Warm Springs/693-2329	Not certain whether waters are pumped or diverted from the River.
Pilgeram, Zane	Gold Creek/288-3356	Either diverting or pumping large amounts of water in the vicinity of Gold Creek; tailings are present on his property.
Probert, Ray	S. of Deer Lodge/ 846-3138	Possibly diverts water from the West Side Ditch.
Ragsdale, Audrey	641 Gem Back Rd./846-2480	Owns an inactive farm having considerable amount of tailings on the property; might have suffered contamination problems historically.
Reistad, Melvin E.	291 Greenhouse Rd./ 846-1377	Either diverts water from the River or uses ground water for crop irrigation purposes.
Rock Creek Cattle Co.	Contact Don Davis, Mgr./ 846-2555 (N. of Deer Lodge)	Own considerable tracts of land adjacent to the River; have diverted surface waters and may be pumping from River also.
Seitz, Greg & Pat	Willow Glen/797-3529	Have lost cattle due to drinking from arsenic-contaminated storm-runoff waters.
Spangler, Hazel	SE. of Opportunity/ 797-3231	Some of her properties may have received aerial deposition of "heavy metals" emitted historically from the smelter stack.
Tamcke, Don	SW. of Deer Lodge/846-1504	Ditto.

TABLE 9.5-5.--POTENTIALLY AFFECTED LANDOWNERS PRESENT WITHIN THE MILE-HIGH AND DEER LODGE VALLEY SOIL CONSERVATION DISTRICTS (CONTINUED)

PART B. DEER LODGE VALLEY SOIL CONSERVATION DISTRICT (DEER LODGE AND POWELL COUNTIES) (CONTINUED)

Landowner(s) Name(s)	Address/Phone No.	Comments
Tammen, Gerald	SE. of Warm Springs/ 693-2254	Owns land adjacent to the AMC (Warm Springs) settling ponds.
Vanisko, John	NW. of Galen/693-2360	Director of the Montana Association of Conservation Districts.

Sources: Landowner plat books in Butte and Anaconda City-County Courthouses plus personal interviews of Ms. Sherry Dutton and Mr. Bob Tribelhorn, USDA SCS (Deer Lodge).

TABLE 6-13.--DERIVATION OF THE ESTIMATE FOR POTENTIALLY AFFECTED, IRRIGATED, LANDS PRESENT WITHIN THE STUDY AREA

Location (Township N Range W)	Acres Affected	Comments
T4NR10W, Sections 21, 28, 35	~ 180	May be affected by seepage from the Yellow Ditch, which diverts water from Silver Bow Creek (T3NR10W, Section 1bbc).
T5NR9W, Sections 29, 30	~ 50	Appears to be irrigated from the Whitcraft Ditch, which may receive some seepage from the Opportunity Ponds (T5NR10W, Section 36cc).
T5NR9W, Section 5	~ 120	Appears to be irrigated from the Helen Johnson and Johnson Ditches.
T5NR10W, Sections 13, 23, 24	~ 580	Possibly affected by seepage or subirrigation (by effluents) from the Opportunity Ponds.
T6NR9W, Sections 20, 21, 29, 32	~ 185	Appears to receive Clark Fork River water from A. Beck, Helen Johnson or Johnson-Hoffman Ditches, or from the West Side Canal.
T6NR9W, Sections 5, 8, 9, 16, 17	~ 465	Apparently receives irrigation waters from the Johnson-Eliason or Eliason Ditches, or from the West Side Canal.
T7NR9W, Sections 4, 5, 8, 9, 17, 20, 29, 32	~ 980	Appears to receive waters from the Valiton East Side and West Side Ditches, the Eliason Lateral Ditch, and the West Side Ditch (Canal).
T8NR9W, Sections 3, 10, 15, 16, 21, 28, 29, 32	~ 1400	Appears to receive waters from the West Side Ditch, Warren Pump/Kohrs-Manning Ditch, Stuart Ditch, Mollenberg-Nelson-Pauly Ditch, and Lahman Ditch.

TABLE 6-A.--DERIVATION OF THE ESTIMATE FOR POTENTIALLY AFFECTED, IRRIGATED, LANDS PRESENT WITHIN THE STUDY AREA (Continued)

Location (Township N Range W)		Acres Affected	Comments
T9NR9W, Sections, 29, 30, 32, 33, 34		~ 380	Appears to receive waters from the Kohrs-Manning Ditch, Larson Ditch, Mollenberg-Nelson-Pauly Ditch, and Lahman Ditch.
T9NR10W, Sections 8, 11, 14, 24		~ 140	Appears to receive waters from the Lahman Ditches, Knop Ditch, and Gilman pump-sprinkler system.
T10NR10W, Section 31		~ 20	Appears to receive water from Dutton pump and ditch system.
T10NR11W, Sections 19-23, 26, 29, 30		~ 880	Appears to receive waters from the Dutton, Wallace, Wallace-Bissonette-Blum and Dunkleburg-Meadows-Turnbull Ditches.
	Σ	~ 5,380	

Sources: Buck et al. 1955 a, b; 1959.